# Prioritized Technology: RPS Orbital and Surface Power - Radioisotope Thermoelectric Generator - eMMRTG

## Technical Goal

- A 2016 study conducted with the mission community identified impediments to using the MMRTG to support science missions.
- The MMRTG degradation causes concerns for the mission since it significantly affects the available power at the mission destination.
  - This is of increased concern for those missions that have longer cruise times before reaching the science destination.
  - The high degradation rate causes the missions to carry an extra unit to meet end of destination power needs for the mission.
  - A lower degradation rate is desired.
    - For reference the MMRTG rate is 4.8%, the eMMRTG goal is 2.5%, the GPHS-RTG rate was 1.8%.

- The technical goal of the eMMRTG path is to transfer the TE materials technology to industry and mature the technology such that the technology can be integrated into a enhanced MMRTG.
- The driving Baseline and Threshold requirements for the eMMRTG respectively are: .
  - The eMMRTG shall have an EODL power greater than or equal to 80We .
  - The eMMRTG will have an EODL power greater than or equal to 73.7We.

## Technical Status - SOA

- The current SOA for RPS is the MMRTG (6% efficiency), which was designed to multi-mission requirements
- MMRTG Engineering Unit successfully tested to the multi-mission levels
- MMRTG F1 was proto-flight tested to the MSL requirements
- Investments made in the thermoelectric (TE) technology area have lead to the development of materials that have a higher efficiency (8% efficiency) and a lower degradation rate.

| Item | Multi-mission | MSL |
|---|---|---|
| **Performance** | | |
| Thermal Inventory | 244-256 W/GPHS | 244-256 W/GPHS |
| BOM power at 28 V | > 110 W | > 110 W |
| Load voltage range | 22-36 Vdc | 22-36 Vdc |
| Mass | <45 kg | <46.5 kg |
| **Loads** | | |
| Random vibration, flight | 0.10 g2/Hz | 0.03 g2/Hz |
| Random vibration, qual | 0.20 g2/Hz | 0.06 g2/Hz |
| Quasi-static load | 30 g | 16 g |
| Pyroshock | 6000 g | 3000 g |
| **Environment** | | |
| Fin root temperature range | 50°C to 200°C | 50°C to 200°C |
| Atmosphere | vacuum & atm | vacuum & atm |

***Definitions***

*Beginning of Life (BOL) is defined as time of fueling*

*Beginning of Mission (BOM) is defined as Launch, and can be as long as 3 years after BOL*

*End of Design Life (EODL) is 17 years after BOL*

***Heat Source***

*Step-2 GPHS, estimated at 244-256 $W_t$ at BOL will be used for this study*

## Mission Applications

- The Baseline requirement results in a system that will provide > 45 % more power over the MMRTG at EODL.
  - By achieving the lower degradation rate of 2.5% as compared to the 4.8% rate of the MMRTG, the eMMRTG would provide > 79% EODL power as compared to the MMRTG.

## Development Cost and Schedule